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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/259,849	03/01/1999	PAUL A. FARRAR	303.557US1	5766

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EXAMINER

PERALTA, GINETTE

ART UNIT PAPER NUMBER

2814

DATE MAILED: 11/27/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/259,849

Applicant(s)

FARRAR, PAUL A.

Examiner

Ginette Peralta

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 03 September 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-77 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-77 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-5, 7-12, 14-15, 17-20, 22-23, 25, 27, 29-30, 32-34, 36-38, 40-42, 44-45, 47-50, 52-56, 58-59, 60, 62-65 and 72 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. in view of Ting et al. and Brown et al. (U.S. Pat. 6,168,704), as previously applied.

Dubin et al. disclose a method of forming a conductor comprising: depositing an insulator 12, as shown in Fig.1 and recited in Col. 1/ll. 32-34; etching a trench 26 having a depth on the insulator, as shown in Fig.2A and disclosed in Col.3/ll. 65-67 and col.4/ll. 1-4; depositing a barrier layer 22 on the insulator, as shown in Fig.2A and disclosed in Col.4/ll. 7-15; depositing a seed layer 25 on the barrier layer 22, as shown in Fig. 3 and recited in Col.4/ll. 29-39; removing the barrier layer 22 and seed layer 25 from selected areas of the insulator, leaving a seed area, as shown in Fig.4 and recited in Col.5/ll. 8-11; depositing a conductor 36 on the seed area by a selective deposition process, as shown in Fig.4 and recited in Col.4/ll. 27-29.

The claim does not preclude the additional step of depositing an intermediate layer 24 shown in Fig.2A or layer 24a,b in Fig.213 as part of the seed layer, as also incorporated in Applicant's invention by virtue of claim 26 (see later). Even if claim 1 would have been so amended such that any additional layer 24 is precluded, eliminating a layer from the prior art which is not required in Applicant's invention is considered obvious. Elimination of a step or element and its function is obvious if the function of the element is not desired or required; *Ex parte Wu*, 10 USPQ 2031 (Bd. Pat. App. & Inter 1989). See also *In re Larson*, 340 F.2d 965, 144 USPQ 347 (CCPA 1965); and *In re Kuhle*, 526 F.2d 553, 188 USPQ 7 (CCPA 1975).

Further, regarding the feature of the conductive layer being deposited after the removal of the seed and barrier layers from selected areas of the insulator, it is noted that the Brown et al. reference teaches the step of removing the barrier and seed layers from selected areas prior to the deposition of the conductor in order to form a seed area where the conductor is deposited, furthermore it is noted that the selection of any order of performing process steps is *prima facie* obvious in the absence of new or unexpected results (*In re Burhans*, 154, F.2d 690, 69 USPQ 330 (CCPA 1946)), thus the removal of the seed and barrier layers prior to the deposition of the conductor in the invention of Dubin et al. would not produce an unexpected result if they were to be removed prior or after the deposition.

However, Dubin et al. do not deposit insulator layer 12 over a planarized surface. Brown et al. deposit an insulator layer 410, 505, 700, 900 over a planarized

surface, as shown in Figs. 4A, 5A, 7A and 9A, reciting the structure. The latter would certainly also include a planarized structure, as is well-known to one of ordinary skill in the art.

It would have been obvious to one having ordinary skill in the art at the time of the invention to deposit Dubin's insulator layer 12 over a planarized surface as shown in Brown et al., since it is an obvious matter of design choice to have a planarized or unplanarized structure underneath Dubin's insulator layer 12 or Brown's insulator layer. Where the instant specification and evidence of record fail to attribute any significance (novel or unexpected results) to a particular arrangement, the particular arrangement is deemed to have been a design consideration within skill of the art. In re Kuhle, 526 F.2d 553, 555, 188 USPQ 7, 9 (CCPA 1975).

Claims 4, 8-10, 12, 15, 19, 23, 27, 30, 34, 38, 42, 45, 50, and 56, recite the same steps as claim 1, however, with specific material limitations imposed on the layers recited, as specifically addressed in the following:

- Regarding claim 3, the limitation that the insulator comprises etching the trench to a depth about equal to the depth of the insulator is disclosed by Brown et al. and it would have been obvious to make the trench with an equal depth in order to contact the underlying surface.
- Regarding claims 4, 12, 15, 19, 23, 42, 45, 50, and 56, the limitation that the insulator layer is made of oxide is disclosed by Dubin et al. in Col. 1/ll. 32-33.

- Regarding claims 8, 9, 27, 30, 34, 38, the limitation that the insulator layer is made of a polymer, specifically polyimide, is disclosed by Ting et al. in Col.8/ll. 36-44.
- Regarding claim 10, it is well known to one of ordinary skill in the art that polymer (claim 8), polyimide (claim 9) and foamed polymer (claim 10) are equally good as interlayer dielectric (ILD). Therefore, substituting polyimide in Ting's insulator layer 11 of Fig. 1 with foamed polymer is not an act of invention, and hence, unpatentable. In re Ruff, 256 F.2d 590, 118 USPQ 340, 343 (CCPA 1958). Unpatentability not only applies where equivalency is disclosed in the prior art, but also where such equivalency would have been obvious. Id. at 599, 118 LISPQ at 348. It would have been obvious to one ordinarily skilled in the art at the time the invention was made to select any one of these materials as a suitable insulator layer of Ting's, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability (e.g., if low-k dielectric is desired) for the intended use as a matter of design choice. In re Leshin, 125 LISPQ 416.
- Regarding claims 12, 15, and 56, the limitation that the barrier layer is made of tantalum or tantalum nitride is disclosed by Dubin et al. in Col.4/ll. 7-15.
- Regarding claims 19, 23, 27, 30, 34, 38, 42, 45, and 50, the limitation that the barrier layer is selected from a group consisting of titanium, zirconium, and hafnium, is disclosed by Ting et al. in Col.6/ll. 56-65, whereby it is expressly recited by Ting et al. that these metals - despite of being specified as seed layer - advantageously also serve as a diffusion barrier, as recited in Col.41-47.

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- Regarding claims 12, 23, 27, 34, 38, and 56, the limitation that the seed layer is made of copper is disclosed by Ting et al. in Col.8/ll. 65-67.
- Regarding claims 15, 19, 27, 30, and 34, the limitation that the seed layer is made of gold or silver, is well-known in the art.
- Regarding claims 42, 45, and 50, the limitation that the seed layer is made of aluminum-copper, is disclosed by Ting et al. in Col.4/ll. 16-25 and Col.4/ll. 40-42.
- Regarding claims 15, 19, 23, 27, 30, 34, 45, and 50, the limitation that the conductive layer is made of gold, silver or aluminum, is well-known in the art.
- Specifically regarding claim 26, the limitation that the step of depositing copper on the seed layer of claim 26 comprises depositing aluminum on the seed area by selective CVD, is rendered obvious by Dubin et al. in Cu-Al alloy layer 24 shown in Fig.2A and Cu & Al layers 24a-b shown in Fig. 213, as recited in Col.4/ll. 16-25 and Col.4/ll. 7-9.
- Regarding claims 2, 7, 11, 14, 17, 20, 25, 29, 32, 36, 40, 44, 47, 52, 54, and 62, the limitation that the barrier layer and/or seed layer is deposited either by the PVD or CVD method is well-known in the art, as recited by Dubin et al. in Col. 1 /ll. 40-42, Col.4/ll. 7-9, and by Ting et al. in Col. 9/ll. 8-10.

The limitation of PVD and CVD as a method of depositing the specified barrier and seed materials is a recitation of intended use (of a PVD or a CVD method). A recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the

claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). Such a manipulative difference is completely absent in the entire disclosure, including the claims. 0 Specifically regarding claims 59 and 60, the limitation of non-anisotropic (i.e., isotropic) deposition technique is already included in Dubin's and Ting's, since PVD and CVD methods are known in the art as isotropic methods.

- Regarding claims 5 and 65, the limitation that the oxide layer is silicon dioxide is disclosed by Dubin et al. in Col. 1/ll. 32-33 and by Ting et al. in Col.8/ll. 36-44.
- Regarding claims 18, 22, 33, 37, and 41, the limitation that the Cu seed layer is deposited by electroless deposition is disclosed by Dubin et al. in Col.1/ll. 47-53 and by Ting et al. in Col. 10/ll. 17-24.
- Regarding claims 48 and 53, the limitation that the Al conductive layer is deposited on the seed layer by CVD is conventional, and hence well-known in the art.
- Regarding claims 49 and 55, the limitation that the Al conductive layer is deposited to an amount sufficient to fill the trench is obvious as this shows that it is well known and desirable in the art of forming a plug or interconnect.
- Regarding claims 58 and 63, the limitation that the copper seed layer is deposited to a depth of approximately five-hundred angstroms thick, or to five-hundred

angstrom below the top of the trench is trivial, since if it is deposited more than the specified amount, it is no longer a seed layer, but a conductive layer.

- Regarding claim 64, the limitation that the TaN barrier layer is deposited above the conductor to a depth of approximately five-hundred angstroms is an obvious matter of design choice within skill in the art that would not yield any unexpected results.

3. Claims 6 and 66 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. in view of Ting et al. and Brown et al. as applied to claims 1-5, 7-12, 14-15, 17, 19-20, 23, 25, 27, 29-30, 32, 34, 36, 38, 40, 42, 44-45, 47, 50, 52, 54, 56, 59, 60, 62, 65 and 72 above, and further in view of Farkas et al.(U.S. Pat. 6,001,730), as previously applied.

Regarding claims 6 and 66, the limitation that the oxide layer is fluorinated silicon oxide is conventional. Fluorinated silicon oxide and silicon dioxide are known in the art as equivalent alternatives for interlayer dielectric (ILD). Farkas et al. teaches in Col.

4/II. 12-23 the use of fluorinated oxide or an oxide for the insulating layer 16, on which a trench for an interconnection similar to the one disclosed by Dubin is taught.

Therefore, substituting silicon dioxide in Dubin's insulator layer 12 of Fig. 1 or Brown's insulator layer with fluorinated silicon oxide is not an act of invention, and hence, unpatentable. In re Ruff, 256 F.2d 590, 118 USPQ 340, 343 (CCPA 1958). Unpatentability not only applies where equivalency is disclosed in the prior art, but also where such equivalency would have been obvious. Id. at 599, 118 USPQ at 348.

It would have been obvious to one ordinarily skilled in the art at the time the invention was made to select any one of these materials as a suitable Dubin's insulator

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layer 12 or Brown's insulator layer, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of design choice. In re Leshin, 125 USPQ 416.

4. Claims 13, 16, 21, 24, 28, 31, 35, 39, 43, 46, 51, 57, 61 and 67-77 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. in view of Ting et al. and Brown et al., and further in view of Nogami et al, as previously applied.

Dubin et al. as modified by Ting et al. and Brown et al. show all the limitations of claims 13, 16, 21, 24, 28, 31, 35, 39, 43, 46, 51, 57, and 61, as previously applied to the respective parent claims 12, 15, 19, 23, 27, 30, 34, 38, 42, 45, 50, and 56, except for specific limitations to be addressed individually in the following:

- Regarding claims 13, 16, 21, 28, 31, 35, 39, 43, 46, 51, 57, and 61, the limitation that the barrier layer is deposited to a depth of between fifty angstroms and one thousand angstroms is well known to one of ordinary skill in the art. This Official Notice is factually supported by Nogami et al. in Col.6/ll. 56-59.
- Regarding claim 24, the claim limitation is the same as that of claims 13 and 19 combined. Claim 24 is therefore rejected over the same prior arts as claims 19 and 13 combined, i.e., taking Nogami's as an additional prior art as applied to claim 13 above.
- Claim 67 recites the same limitations as in claim 1, further specifying the oxide layer as in claim 4, the barrier layer as in claim 12, the seed layer as in claim 27, the conductive layer as in claim 38, and an additional (barrier) layer on the conductive

layer as in claim 56. Claims 1, 4, 12, 27, 38, and 56 having been previously rejected, claim 67 is therefore rejected for the same reason and over the same prior arts as claims 1, 4, 12, 27, 38, and 56, combined.

- Claim 68 recites the same limitations as in previously rejected claim 57.
- Claim 69 recites the same limitations as in previously rejected claim 58. Claim 70 recites the same limitations as in previously rejected claim 59. Claim 71 recites the same limitations as in previously rejected claim 61.
- Regarding claims 72 and 73, depositing TaN and Cu by the CVD method is conventional.
- Regarding claim 74, the limitation that the copper conductive layer is deposited to a depth of about five-hundred angstroms below the top of the trench is trivial, since space must be provided for the overlying TaN barrier layer to fill up the trench, as implicated in the parent claim 67.
- Regarding claim 75, the limitation that the TaN barrier layer is deposited over the copper conductive layer to a depth of about five-hundred angstroms -- combined with the limitation of claim 74 - is essentially the same as filling up the trench with Cu conductive layer of claim 74 and TaN barrier layer of claim 75, and hence, is trivial to one of ordinary skill in the art.
- Claim 76 recites the same limitations as in previously rejected claims 65 and 5.
- Claim 77 recites the same limitations as in previously rejected claims 66 and 6.

Response to Arguments

1. Applicant's arguments filed 9/12/02 have been fully considered but they are not persuasive.

2. In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, the limitation of "depositing an insulator over a planarized surface" is a well known process step that is demonstrated by the Brown et al. reference, it is well known in the art to deposit over planarized surfaces in order to maintain a better step coverage, a better surface for subsequent depositions and to provide a better surface upon which photolithography steps will be applied, like is well known in the art.

3. In response to applicant's argument that Dubin et al. deposits the seed layer on a copper-aluminum film and not on a barrier layer as the claim recites, it is noted that Dubin et al. performs an anneal process to form an aluminum/copper/titanium nitride multilayer film, thus the copper-aluminum film becomes part of the barrier layer, and the seed layer is therefore deposited on the barrier layer.

4. In response to applicant's argument that Dubin et al. as modified by Brown et al. does not teach the step of "depositing a conductor... after removing the barrier layer and seed layer from selected areas of the insulator", it is noted that Brown et al. teaches in Fig. 4A-4C a series of steps that include removing the barrier and seed layer (400A and 400B) from selected areas of insulator 420, and depositing a conductor 425 after the selective removal of the barrier and seed layers.

Conclusion

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).


A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ginette Peralta whose telephone number is (703)305-7722. The examiner can normally be reached on Monday to Friday 8:00 AM-4:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on (703)308-4918. The fax phone numbers for the organization where this application or proceeding is assigned are (703)308-7722 for regular communications and (703)308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703)308-0956.

GP
November 21, 2002



LONG PHAM
PRIMARY EXAMINER